REMARKS

Claims 1, 2, 8, 9, 13, 15-17, 19, 28, 30, 32, 39, 42, 45, 48, 51, 54, 57, 60, 63, 66, 68 and 70 are amended herein. Claims 1-21, 23, 25 and 27-77 remain pending in the application, with claims 27-77 being withdrawn from consideration by the Examiner.

Allowable Claims

The Applicant thanks the Examiner for the indication that claims 8, 15 and 17 contain allowable subject matter. The Examiner has withdrawn the allowability of claims 16-20, 22 and 25.

Claim 8 was previously indicated as containing allowable subject matter and was amended to be in independent form including all limitations from any higher order claims.

The Examiner now indicates claims 15 and 17 contain allowable subject matter. Claims 15 and 17 are amended herein to be in independent form including all of the limitations of any intervening claims.

Claims 8, 15 and 17 are now in condition for allowance.

Claims 1-7 over Chen in view of Nagamitsu

In the Office Action, claims 1-7 were rejected under 35 USC 103(a) as allegedly being obvious over Chen, U.S. Pat. No. 5,500,900 to Chen ("Chen") in view of Nagamitsu, U.S. Pat. No. 5,467,401 ("Nagamitsu"). The Applicant respectfully traverses the rejection.

The Office Action rejected claims 1-7 over Nagmitsu, without providing a patent number. The Examiner previously cited Nagamitsu, U.S. Pat. No. 5,467,401. The Applicant is herein responding to Nagamitsu as cited by the Examiner.

Claims 1-7 recite, *inter alia*, a characteristic function representing a head-related **impulse response** includes a special characteristic function determined for a selected number of samples and a selected number of **eigen values**.

Chen discloses a free-field-to-eardrum transfer function (FETF, an previous name for an HRTF) developed by comparing auditory data for points in three-dimensional space for a model ear and auditory data collected for the same listening location with a microphone (Abstract). Each FETF is represented as a weighted sum of frequency-dependent functions obtained from an expansion of a measured FEFT covariance matrix (Chen, Abstract). Spatial transformation characteristic functions (STCF) are applied to transform the weighted frequency-dependent factors to functions of spatial variables for azimuth and elevation (Chen, Abstract). A generalized spline model is fit to each STCF to filter out noise and permit interpolation of the STCF between measured points (Chen, Abstract). A spline model used to generate the STCFs, smooths measurement noise and enables interpolation of the STCFs between measurement directions (Chen, col. 5, lines 18-20). A regularizing parameter within the spline model controls a trade-off between smoothness of a solution and its fidelity to the data (Chen, col. 5, lines 29-31).

The Office Action relies on Nagamitsu to allegedly make up for the deficiencies in Chen to arrive at the claimed invention. The Applicant respectfully disagrees.

Nagamitsu appears to disclose a sound environment simulator including a sound field analyzing unit, a sound field reproducing unit, and an output unit (Abstract). The sound environment analyzing unit divides the solid surfaces of a space to be analyzed into a set of sections to compute a volume with a sound absorption coefficient of walls and form factors (Nagamitsu, Abstract). Time series data relates to the arrival volume of sounds emanated from a certain sound source to a sound receiving point (Nagamitsu, Abstract). An impulse response computing unit in the sound field reproducing unit transduces the time series data into an impulse response (Nagamitsu, Abstract). A sound receiving point receives two types of sounds, a direct sound from the sound source and a reflected sound (Nagamitsu, col. 6, lines 39-42).

Chen discloses use of a head related transfer function within the background of the invention. A head related transfer function is **NOT** a head-related impulse response. Chen fails to disclose processing multiple sound

sources efficiently to generate three dimensional sounds with multiple sources based on a head-related impulse response, much less filtering based on a head-related impulse response that includes a special characteristic function determined for a selected number of samples and a selected number of **eigen values**, as recited by claims 1-7.

Moreover, Chen fails to disclose or suggest eigen values at all, much less a head-related **impulse response**. Chen discloses use of a head related transfer function within the background of the invention. A head related transfer function is **NOT** a head-related impulse response. Chen fails to disclose processing multiple sound sources efficiently to generate three dimensional sounds with multiple sources based on a head-related impulse response, much less filtering based on a head-related impulse response that includes a special characteristic function determined for a selected number of samples and a selected number of **eigen values**, as recited by claims 1-7.

Nagamitsu fails to teach a spatial function that represents a head-related impulse response.

Neither Chen nor Nagamitsu, either alone or in combination, disclose, teach or suggest filtering based on a head-related impulse response, as claimed by claims 1-7.

There are significant advantages of using eigen values as claimed by the present invention. For instance, as disclosed in the specification of the present application in the last paragraph of page 4, "[i]nstead of representing HRIR using measured discrete samples at many directions, the present invention employs a linear combination of a set of eigen filters (EFs) and a set of spatial characteristic functions (SCFs)." These eigen filters are functions of frequency or discrete time samples only (i.e., NOT dependent upon distance). Thus, the need for the creation of a separate HRTF for each source and each early reflection as is conventionally required is avoided. (See, e.g., specification, page 3, lines 5-7).

Accordingly, for at least all the above reasons, claims 1-7 are patentable over the prior art of record. It is therefore respectfully requested that the rejections be withdrawn.

Claims 9, 13, 21, 23 and 25 over Begault in view of Kendall

In the Office Action, claims 9, 13, 21, 23 and 25 were rejected under 35 USC 103(a) as allegedly being obvious over Begault, U.S. Patent No. 5,438,623 ("Begault") in view of Kendall et al., U.S. Patent No. 4,731,848 ("Kendall"). The Applicant respectfully traverses the rejection.

Claims 9 and 13 recite, *inter alia*, an **input** for receiving a signal representing sound originating at a plurality of positions in space, the plurality of positions including multiple reflections, multiple sources without reflections, and multiple sources with multiple reflections, and a left channel and a right channel, where each channel comprises a filter array for applying a filter to a signal received by an input to provide a filtered signal, the filter comprising a linear function including a spatial component which comprises a head-related impulse response.

Begault appears to disclose a head-related transfer function that can be recorded using an impulse response. (Begault, col. 1, lines 54-57). Begault discusses the digital implementation of the binaural impulse response by convolving the input signal in the time domain with the impulse response of two HRTFs using two finite impulse response filters. (Begault, col. 1, lines 59-63).

The Office Action correctly acknowledged that Kendall fails to disclose an input for receiving a signal representing sound originating at a plurality of positions in space (Office Action, page 4). The Office Action relies on Kendall to allegedly make up for the deficiencies in Begault to arrive at the claimed invention. The Applicant respectfully disagrees.

Kendall appears to disclose processing audio signals utilizing reverberation in combination with directional cues to capture both a temporal and spatial dimensions of a three-dimensional natural reverberant environment (Kendall, Abstract). A spatial reverberator processes a sound input signal applied to an input such that when output signals are reproduced, an illusionary experience is created of being within a natural acoustic environment by creating a perception of reflected sound coming from many different directions in three-dimensional space (Kendall, col. 4, lines 13-19). The input signal is processed by a directionalizer which superimposes directional cues, preferably including

pinna cues using synthesized pinna transfer functions to directionalize the audio signal (Kendall, col. 6, lines 31-39).

Kendall is relied on to disclose an input for receiving a signal representing sound originating at a plurality of positions in space (Office Action, page 2). However, Kendall discloses a method and apparatus for taking a simple sound as an input and producing a sound signal that sounds as if it was a produce of a plurality of reflections. Once the sound signal is produced having a plurality of reflections, no further processing is performed on the sound signal, with the sound signal being converted to an audible form. Kendall fails to disclose an input for receiving a signal representing sound originating at a plurality of positions in space, much less one where the plurality of positions including multiple reflections, multiple sources without reflections, and multiple sources with multiple reflections, and a left channel and a right channel, where each channel comprises a filter array for applying a filter to a signal received by an input to provide a filtered signal, the filter comprising a linear function including a spatial component which comprises a head-related impulse response, as recited by claims 9 and 13.

Even if the theoretical combination of Begault and Kendall were obvious (which it is not), the theoretical combination would result in a digital implementation of a binaural impulse response by convolving an input signal in a time domain with an impulse response of two HRTFs using two finite impulse response filters. The input signal would be inputted into a reverberator which superimposes directional cues, preferably including pinna cues using synthesized pinna transfer functions to directionalize the audio signal. The theoretical combination of Begault and Kendall would still fail to disclose an input to a signal processing elements being multiple reflections, multiple sources without reflections, and multiple sources with multiple reflections, as recited by claims 9 and 13.

Neither Begault nor Kendall, either alone or in combination, disclose, teach or suggest an input for receiving a signal representing sound originating at a plurality of positions in space, much less one where the plurality of positions including multiple reflections, multiple sources without reflections,

and multiple sources with multiple reflections, and a left channel and a right channel, where each channel comprises a filter array for applying a filter to a signal received by an input to provide a filtered signal, the filter comprising a linear function including a spatial component which comprises a head-related impulse response, as recited by claims 9 and 13.

Claim 21 recites, *inter alia*, a plurality of filters that remain constant, with at least one of at least one delay element, at least one attenuator, and plurality of weighting elements adapted to change a perceptive position of a sound source signal to a listener, with a plurality of sound signals comprise multiple reflections, multiple sources without reflections, and multiple sources with multiple reflections. Claims 23 and 25 recite, *inter alia*, a filtered attenuated sound signal that remains constant, with at least one of a delayed sound source signal, an attenuated sound source signal, and weighted filtered sound signals that are adapted to change a perceptive position of a sound source signal to a listener, with a plurality of sound signals comprising multiple reflections, multiple sources without reflections, and multiple sources with multiple reflections.

As discussed above, Begault discloses a head-related transfer function that can be recorded using an impulse response. (Begault, col. 1, lines 54-57). Begault discusses the digital implementation of the binaural impulse response by convolving the input signal in the time domain with the impulse response of two HRTFs using two finite impulse response filters. (Begault, col. 1, lines 59-63).

The Office Action correctly acknowledged that Begault fails to disclose sound reflections as claimed (Office Action, page 5). The Office Action relies on Kendall to allegedly make up for the deficiencies in Begault to arrive at the claimed invention. The Applicant respectfully disagrees.

Kendall is relied on to disclose sound reflections from a plurality of directions. However, as discussed above, Kendall is producing a sound signal that sounds as if it is produced by a plurality of reflections. Kendall fails to disclose performing operations to a plurality of sound signals, much less to a plurality of sound signals comprising multiple reflections, multiple sources without

reflections, and multiple sources with multiple reflections, as recited by claims 21, 23 and 23.

Neither Begault nor Kendall, either alone or in combination, disclose, teach or suggest a plurality of filters that remain constant, with at least of a delay element, at least one attenuator, and plurality of weighting elements adapted to change a perceptive position of a sound source signal to a listener, and a filtered attenuated sound signal that remains constant, with at least one of a delayed sound source signal, an attenuated sound source signal, and weighted filtered sound signals that are adapted to change a perceptive position of a sound source signal to a listener, with a plurality of sound signals comprising multiple reflections, multiple sources without reflections, and multiple sources with multiple reflections, as recited by claims 21, 23 and 25.

The Examiner proposes to modify Begault with Kendall to arrive at the claimed invention of claims 9, 13, 21, 23 and 25. However, Begault was not designed to process such a large number of sound signals as Applicant's invention. Providing a secondary reference, such as Kendall, to be combined with a system designed to handle far fewer sound signals, Begault, would still not arrive at the Applicant's invention. Begault would have to be completely redesigned to handle such a large number of sound signals, thus changing the purpose of Begault's invention, **NOT** an obvious modification.

Accordingly, for at least all the above reasons, claims 9, 13, 21, 23 and 25 are patentable over the prior art of record. It is therefore respectfully requested that the rejections be withdrawn.

Claims 10-12, 14, 16 and 18 over Begault in view of Kendall and Chen

Claims 10-12 and 14 were rejected under 35 USC 103(a) as allegedly being obvious over Begault in view of Kendall, and further in view of Chen, with claim 16 and 18 rejected under 35 USC 103(a) as allegedly being obvious over Chen in view of Kendall. The Applicant respectfully disagrees.

Claims 10-12 and 14 are dependent on claim 9, and are allowable for at least the same reason as claim 9.

Claims 10-12 and 14 recite, *inter alia*, an input for receiving a signal representing sound originating at a plurality of positions in space, the plurality of positions including multiple reflections, multiple sources without reflections, and multiple sources with multiple reflections, and a left channel and a right channel, where each channel comprises a filter array for applying a filter to a signal received by an input to provide a filtered signal, the filter comprising a linear function including a spatial component which comprises a head-related impulse response.

As discussed above, neither Begault nor Kendall, either alone or in combination, disclose, teach or suggest an input for receiving a signal representing sound originating at a plurality of positions in space, much less one where the plurality of positions including multiple reflections, multiple sources without reflections, and multiple sources with multiple reflections, and a left channel and a right channel, where each channel comprises a filter array for applying a filter to a signal received by an input to provide a filtered signal, the filter comprising a linear function including a spatial component which comprises a head-related impulse response, as recited by claims 10-12 and 14.

The Examiner acknowledged that Chen fails to disclose a sound originating at a plurality of positions in space (Office Action, page 2).

Neither Begault, Kendall nor Chen, either alone or in combination, disclose, teach or suggest an input for receiving a signal representing sound originating at a plurality of positions in space, much less one where the plurality of positions including multiple reflections, multiple sources without reflections, and multiple sources with multiple reflections, and a left channel and a right channel, where each channel comprises a filter array for applying a filter to a signal received by an input to provide a filtered signal, the filter comprising a linear function including a spatial component which comprises a head-related impulse response, as recited by claims 10-12 and 14.

Claims 16 and 18 recite, *inter alia*, a signal **input** for receiving a signal representing sound originating at a plurality of positions in space, and a left channel and a right channel comprising a source placement array for filtering the sound signal in accordance with a spatial characteristic function, wherein the

spatial characteristic function is a head-related impulse response, a plurality of eigen filters attached to a source placement array and receiving the signal therefrom, wherein the eigen filters introduce time delays into the signal.

Chen fails to disclose or suggest the use of eigen fitlers at all, much less a head-related impulse response used with a plurality of eigen filters attached to a source placement array and receiving the signal therefrom, wherein the eigen filters introduce time delays into the signal, as recited by claims 16 and 18.

The Office Action correctly acknowledged that Kendall fails to disclose an input for receiving a signal representing sound originating at a plurality of positions in space (Office Action, page 4).

Neither Chen nor Kendall, either alone or in combination, disclose, teach or suggest a signal **input** for receiving a signal representing sound originating at a plurality of positions in space, and a left channel and a right channel comprising a source placement array for filtering the sound signal in accordance with a spatial characteristic function, wherein the spatial characteristic function is a head-related impulse response, a plurality of eigen filters attached to a source placement array and receiving the signal therefrom, wherein the eigen filters introduce time delays into the signal, as recited by claims 16 and 18.

Accordingly, for at least all the above reasons, claims 10-12, 14, 16 and 18 are patentable over the prior art of record. It is therefore respectfully requested that the rejections be withdrawn.

Claim 20 over Chen in view of Kendall and Sekine

Claim 20 was rejected under 35 USC 103(a) as allegedly being obvious over Chen in view of Kendall, and further in view of Sekine et al. U.S. Patent No. 5,822,438 ("Sekine"). The Applicant respectfully disagrees.

Claim 20 is dependent on claim 16, and is allowable for at least the same reasons as claim 16.

Claim 20 recites, *inter alia*, a signal **input** for receiving a signal representing sound originating at a plurality of positions in space, and a left

channel and a right channel comprising a source placement array for filtering the sound signal in accordance with a spatial characteristic function, wherein the spatial characteristic function is a head-related impulse response, a plurality of eigen filters attached to a source placement array and receiving the signal therefrom, wherein the eigen filters introduce time delays into the signal.

As discussed above, neither Kendall nor Chen, either alone or in combination, disclose or suggest a signal **input** for receiving a signal representing sound originating at a plurality of positions in space, and a left channel and a right channel comprising a source placement array for filtering the sound signal in accordance with a spatial characteristic function, wherein the spatial characteristic function is a head-related impulse response, a plurality of eigen filters attached to a source placement array and receiving the signal therefrom, wherein the eigen filters introduce time delays into the signal, as recited by claim 20.

The Office Action relies on Sekine to allegedly make up for the deficiencies in Kendall and Chen to arrive at the claimed invention. The Applicant respectfully disagrees.

Sekine appears to disclose an electronic musical instrument that provides a sound image position control (Abstract). The apparatus provides a signal mixing portion and a virtual-speaker position control portion (Sekine, Abstract). Various delayed signals are multiplied by a predetermined coefficient to create virtual speaker sounds (Sekine, col. 5, line 66-col. 6, line 27). A head transfer function is created from an observation of experimental values obtained from a transfer function of a dummy head (Sekine, col. 5, ilnes 21-57).

Sekine fails to disclose or suggest use of eigen filters in combination with a head-related impulse response for a signal **input** for receiving a signal representing sound originating at a plurality of positions in space, as recited by claim 20.

Neither Chen, Kendall nor Sekine, either alone or in combination, disclose, teach or suggest a signal **input** for receiving a signal representing sound originating at a plurality of positions in space, and a left channel and a right channel comprising a source placement array for filtering the sound signal in

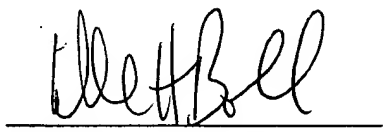
accordance with a spatial characteristic function, wherein the spatial characteristic function is a head-related impulse response, a plurality of eigen filters attached to a source placement array and receiving the signal therefrom, wherein the eigen filters introduce time delays into the signal, as recited by claim 20.

Accordingly, for at least all the above reasons, claim 20 is patentable over the prior art of record. It is therefore respectfully requested that the rejections be withdrawn.

Conclusion

All objections and rejections having been addressed, it is respectfully submitted that the subject application is in condition for allowance and a Notice to that effect is earnestly solicited.

Respectfully submitted,



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